Argonne NATIONAL LABORATORY

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Feature

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Getting to know bacteria with "multiple personalities"

Cyanobacteria, or blue-green algae, have been the subject of decades of debate over exactly how they should be classified. While they reproduce and share DNA with their bacterial cousins, they are the only phylum of bacteria that can photosynthesize like plants

"Scientists have long considered cyanobacteria to have 'multiple personalities,' as it were," said Andrzej Joachimiak, who directs the Structural Biology Center (SBC) at the U.S. Department of Energy's Argonne National Laboratory. "They are unique creatures in that they form key components of so many different ecological processes."

Joachimiak and his colleagues at the SBC, the NIH-funded Midwest Center for Structural Genomics and the University of Chicago recently studied one particular phenomenon in cyanobacteria known as "heterocyst differentiation." Cyanobacteria cells group themselves into long filaments that can contain dozens and even hundreds of cells – and like in humans, not all cyanobacteria cells are born the same. While most cyanobacteria cells aid in photosynthesis, occasionally a cell is produced that transforms atmospheric nitrogen into ammonia in a process known as "nitrogen fixation."

"Photosynthesis and nitrogen fixation are two of the most important and ubiquitous biochemical environmental processes that we know of," Joachimiak said. "If we can understand and manipulate how these bacteria differentiate themselves, we can better use natural pathways

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to mimic natural processes for a wide number of different applications, including the potential creation of biofuels."

Heterocyst differentiation is controlled in cyanobacteria by a special protein known as HetR, which recognizes and binds to specific region of the bacteria's DNA. The action of HetR, in turn, is mediated by inhibitors that control how often a photosynthetic cell turns into a nitrogen-fixing one.

In the long term, Joachimiak hopes that the SBC can synthesize and characterize inhibitors that can control how cyanobacteria "switch." In order to do so, scientists have to use the high-energy X-rays provided by Argonne's Advanced Photon Source. In the research, a tightly focused X-ray beam was directed onto a small crystalline sample of HetR protein. The resulting pattern of scattered light enabled the researchers to identify the protein's structure.

The action of HetR is controlled by an action called dimer formation, wherein two separate HetRs join together to form a larger structure, which had not been observed before. This two-unit structure is what binds to the bacterium's DNA. Joachimiak said that he believes the HetR/DNA complex attracts other proteins that initiate cell differentiation.

Since its establishment in 1998, the SBC has contributed more than 3,250 separate structures to the Protein Data Bank, and SBC research has resulted in the publication of more than 1,100 scientific papers.

By Jared Sagoff # # # #